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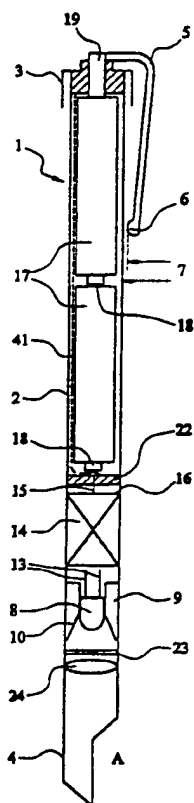
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[Continued on next page]

(54) Title: APPARATUS FOR PRODUCING ULTRA-VIOLET LIGHT



(57) Abstract: A portable, self-contained, electrically safe apparatus for producing Ultra-Violet (UV) light comprises a source of electrical power (17), a source of UV light (8) and means (15, 14, 13, 9) to connect the source of UV light to the source of power and convert it to a form suitable to operate the source of UV light. The UV light source may be a miniature UV bulb or light emitting diode (LED) and the power source may be an internal battery. The miniature bulb or LED is preferably of the low voltage (20-30V) type. An external power source may be provided as back up. The apparatus may include an optical system (23, 24) to focus and filter the light output. The apparatus may be in the form of a 'light pen' which fits in a pocket and the clip may serve as the switch. The apparatus may be used for detecting forged banknotes or other documents, etc., identifying stolen goods and for medical or scientific purposes.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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APPARATUS FOR PRODUCING ULTRA-VIOLET LIGHT

This specification relates to apparatus for producing ultra-violet (UV) light.

5 Generally, known apparatus for producing UV light include UV bulbs which are relatively large, e.g. the size of a fist, and require high voltage power (e.g. 400-600V) to operate them. Such apparatus need a significant power supply, have their associated
10 electrical systems and also require extensive insulation to ensure electrical safety for the operator. As such, these apparatus are not portable in the sense that the user can carry them around on his/her person, or in a toolbag, and use them as and
15 when required, e.g. out of doors or away from mains power supplies. While it is possible to provide a battery powered system, this would of necessity be heavy, bulky and inconvenient.

 UV light is important in many forms of scientific
20 work, for example, medical practitioners may use it to indicate skin conditions and many insects and birds have eyes which are sensitive to parts of the UV spectrum. One method of detecting forged bank notes is to examine them under UV light because the paper on
25 which they are printed does not fluoresce, in contrast to the majority of papers available to, and normally used by, forgers. As a further means of eliminating forgeries, some bank notes have printing which is visible only under UV light, for example, a ten
30 denomination note may have the number '10' printed on it in this ink so that it is invisible in normal light but shows up strongly in UV light. These 'subliminal' figures are an important anti-forgery feature in some countries.

35 It would clearly be advantageous if the police, and others involved with the detection of forged bank

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notes, could have a handy source of UV light, so that both the fluorescence and subliminal numbers could be checked during the course of their investigations, for example, when they detain a suspect in the street.

5 One means of protecting valuables, e.g. computers, video recorders etc., is to mark the owners' details on the equipment using a UV marker. This leaves data which is invisible to the naked eye, but which stands out clearly under UV light. Police and Trading
10 Standards investigators would find a portable apparatus for producing UV light very useful when investigating suspects who are trying to sell such equipment cheaply and which may be stolen property.

15 There is thus a need for a portable, electrically safe apparatus for producing UV light which can, ideally, be carried in a jacket pocket and used as and when required, without connection to a separate power source. Moreover there is a need for such an apparatus which can be used in the presence of bright light.

20 According to the present invention, there is provided a portable and self-contained apparatus for producing UV light, comprising:-

- i) a source of electrical power;
- ii) a source of UV light requiring a low -
25 operating voltage; and
- iii) means to connect said source of UV light to said source of electrical power and to convert the electrical power to a form suitable to operate said UV light source.

30 In one embodiment of the apparatus of the invention, the source of UV light is miniaturised and a reflector is provided to concentrate the light output in a specific direction.

35 In another embodiment of the apparatus of the invention, the power and UV light sources and the connecting and converting means are accommodated in a

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housing including an aperture to enable a beam of the UV light to leave the apparatus and be directed at an object to be examined located externally of the apparatus. The housing may terminate in a hood to concentrate the UV light.

In a further embodiment of the apparatus of the invention, the housing is provided with an electrical switch to control the supply of power to the UV light source.

In another embodiment of the apparatus of the invention, an optical system comprising, for example, a collimating lens is provided to concentrate the UV light emitted by the source.

In a preferred example of the apparatus of the invention, the power source comprises one or more batteries, which may be of the rechargeable type, and the UV light source is a point source such as a miniature UV bulb, or better still, a UV light emitting diode (LED). Such bulbs or LEDs may be of the order of 5mm diameter by about 10 mm long, or even smaller, and require a low voltage (e.g. 20-30V) to operate them. Electrical/electronic circuitry is provided to convert the battery output to the required power characteristics to operate the bulb/LED. This can be achieved via the use of a high frequency boost converter.

Any suitable form of housing may be provided, but a cylindrical tube similar in size to that of a pen is preferred, as this allows the battery(ies) to be located axially with the converting means located nearer one end of the housing and the bulb/LED located at that end so that the UV light is directed out of the end of the housing. Such apparatus can be easily carried in a jacket pocket. A key fob is another possible form of housing with the components arranged to fit the space available inside the fob.

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Preferably an electrical switch is incorporated into the housing so that the UV light may be turned on and off, as required.

5 A reflector may be provided in the apparatus to direct the light in a solid angle along the axis of the housing. The reflector may be combined with a holder for the bulb/LED so as to make best use of the space available. In a preferred embodiment, an optical system e.g. a collimating lens, may be used to focus
10 the light and a hood, in the form of, for example an extension of the housing, may be provided to direct the light more accurately onto a small object. The optical system may include an optical filter to select particular wavelengths of UV light.

15 In another embodiment, the mains supply or an external battery may be used as the source of power.

In the case where the source of electrical power is one or more internal batteries, the housing may be adapted for connection to an external power source,
20 such as a mains supply or a car battery. The housing may then include circuitry designed to by-pass the internal batteries, when the apparatus is connected to the external power source, and so conserve their life. Alternatively, rechargeable batteries may be used in
25 which case the circuitry may be designed to recharge them whenever external power sources are used.

In a particularly preferred embodiment, the apparatus comprises a housing having an aperture and accommodating

- 30 (i) a battery,
(ii) a UV light emitting diode,
(iii) high frequency boost converter circuitry which connects the battery and diode and converts the electrical power of the battery into a form
35 suitable to operate the diode, and
(iv) an optical system to focus the UV light

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emitted by the diode and direct it out of the housing via the aperture so as to illuminate an object located externally of the housing.

For a better understanding of the invention and to show how it may be put into effect, reference will now be made, by way of example only, to the accompanying drawings in which:

Figure 1 is a sectional elevation of one embodiment of an apparatus of the invention;

Figure 2 shows a part sectional detail of the optical system of the apparatus of Figure 1;

Figure 3 is a part sectional elevation of the screw cap end of the apparatus of Figure 1 and also shows a separate cap for connecting the apparatus to an external power source;

Figure 4 shows a functional circuit diagram of a high frequency boost converter; and

Figure 5 is a sectional elevation of another embodiment of an apparatus of the invention.

In the drawings, like parts are denoted by the same reference numerals.

Figure 1 shows a section through a first embodiment of an apparatus 1 of the invention. It comprises a cylindrical housing 2 closed at one end by a cap 3 and having a hooded extension 4 at its other end enveloping an aperture through which the UV light is emitted. A clip 5 is provided to secure the apparatus in a pocket, like an ordinary pen clip. Two batteries 17, e.g. AAA size 1.5V, are fitted in series between cap 3 and insulator 22 where the positive terminal 18 of battery 17 contacts the end of a conductor 15. Electronic circuitry 14 converts the batteries' output to the power required for miniature UV light source 8 which is connected via wires 13 to the electronic circuitry 14.

The miniaturised UV light source 8 is preferably a

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UV light emitting diode (LED) since these have a high power to light conversion efficiency. However low voltage UV bulbs or the like may be used. A particular feature of such UV light sources is that they require only low operating voltages, e.g. 20-30V. Such low levels of voltage, and equivalent levels of current, make the apparatus intrinsically electrically safe with the normal types of insulator used in torches and other battery operated equipment. This is important, as the previously available types of UV light source required operating voltages of the order of 400-600V, with concomitant safety implications. Such light sources are not operable by portable battery power sources.

A combined holder 9 and reflector 10 holds UV light source 8 and directs the light output axially forward through an optical system comprising an optical filter 23 and a collimating lens 24, which produces essentially parallel rays of light down into the hooded extension 4, which then concentrates the light output into a narrow diverging beam that leaves the apparatus to impinge on a banknote or other object, located externally of the apparatus and indicated by A.

Figure 2 shows the optical system in more detail. Wires 13 connect the sockets 12 in the holder 9 to the circuitry 14. As shown, the UV light source 8 is a push fit with contacts 11 engaging in the sockets 12. The forward facing cone of holder 9 forms a reflector 10 to direct the light into the hooded extension. Optical filter 23 is shown as one example of a component of the optical system. It selects the required UV wavelengths, e.g. 330-370 nm.

Light rays 28 are shown emitting radially from source 8 via filter 23 into collimating lens 24 from which they emerge as parallel rays, some of which will reflect off the polished internal surface 25 of the angled end 26 of hooded extension 4. Another ray 29 is

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shown being emitted from the side of the source 8 and reflected off reflector 10 and surface 25 to pass through collimator 24 at a different angle, but it will still be focussed on the object at A, as shown by the dashed arrow. The means of securing filter 23 and lens 24 is not shown in detail, but it will be apparent to the man skilled in the art. Also not shown is a means of separating the housing 2 between holder 9 and filter 23 so that the light source 8 may be replaced, if required. Another adaptation is that a range of slip-on hoods 4 may be provided for different applications of the apparatus.

Referring to Fig.3, cap 3 is shown secured via screw thread 20 to the outside of housing 2. An insulator 21 is fast with the inside of cap 3 and contains an axial conductor 19 which contacts the bottom of battery 17, thus making the negative connection. Clip 5, fast with contact 19, extends downwardly along the outside of housing 2 and serves as a switch to control the light source. As illustrated in Figure 1, the end of clip 5 terminates in a contact 6 which, as shown by arrows 7, is clear of the housing 2. By pressing clip 5 so that end 6 contacts housing 2, the electrical circuit is closed and power flows from batteries 17 into circuitry 14. The circuitry 14 is in electrical contact with housing 2 as shown by connection 16. Thus, closure of contact 6 will complete the electrical circuit and cause light source 8 to be lit.

Figure 4 is a functional circuit diagram of a high frequency boost converter constituting electronic circuitry 14. This device converts the relatively low voltage (e.g. 1.5V) of the batteries 17 to the higher voltage (e.g. 20-30V) required to operate the miniature UV light source 8.

Figure 5 shows a section through a preferred

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embodiment of the apparatus of the invention in which the source of UV light 8 is a UV LED. The construction of the apparatus illustrated in Figure 5 is the same as that shown in Figure 1 except that the UV LED light source has a lens 24a directly attached to the side facing the aperture and the reflector (feature 10 in Figure 1) is omitted. In addition, this embodiment has a cylindrical hooded extension 4a which has an aperture that is coaxial with the aperture of the cylindrical housing 2.

In an example of possible usage of the apparatus of the invention, a traffic policeman may stop a suspect car and approach the driver. The policeman may have reason to believe the driver is passing forged notes and ask to see a note from his/her wallet. He will then be able to take the UV light pen 1 from his pocket and, by pressing clip 5, examine the note to see whether the paper fluoresces or not and whether any hidden numbers are revealed by the UV light. The provision of hooded extension 4 (4a) concentrates the light onto the note and allows it to be examined even in bright sunlight. If the note appears to be forged, the policeman can then arrest the suspect.

The test for fluorescence is to some extent a 'negative' test in that, if the note does not fluoresce, it does not necessarily mean that the note is genuine as it could have been forged on non-fluorescent paper. However, the presence of subliminal UV numbers is a 'positive' identification of the note's authenticity. In addition to subliminal numbers, some banknotes are printed on paper containing specially added impurities which fluoresce under UV light and this is a further means of verification.

Another example of the use of the UV light pen is when Trading Standards representatives visit car boot sales, etc. where electronic goods are being sold

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cheaply. An examination of the equipment with the UV light pen will show any identification markings which may have been placed there by the original owner, and prove if the goods have been stolen. Some spirits are
5 produced especially for export and are not subject to UK tax. It is not unknown for such merchandise to be stolen before leaving the country and to be sold illegally within the UK. Here again, subliminal UV markings could identify the goods.

10 Naturalists, medical practitioners, forensic and other scientists, etc. may use UV light pens for experiments with insects, etc., diagnostic tests, solving crimes or general scientific research.

A modification which maximises battery life by
15 using external sources of power is also shown in Figure 2. A removable cap 30 is fitted over cap 3 and clip 5 and is held in place by springs 31,32. An insulated conductor 41 (Figure 1; shown as a dashed line) runs from connection 15 to a spring 35 (Figure 2) which
20 contacts ring conductor 36 fitted in annular recess 42 in insulator 21. Because recess 42 is an annulus, cap 3 can be screwed on and off without breaking spring 35 and spring 35 will contact ring 36 irrespective of the orientation of cap 3. Spring 35 is insulated from
25 housing 2 and is shaped so that batteries 17 may be slid in, or out, of housing 2 past spring 35, without snagging.

Wire 37 connects ring conductor 36 to contact 38. Mating contacts 39 and 40 touch contact 38 and the end
30 of conductor 19, respectively, when cap 30 is fitted, enabling connection to an external power source via a suitable lead. The external power may be AC mains, via a transformer as necessary, or a 12V DC car battery. Circuitry 14 is adapted to convert the incoming power
35 to that required for the light source 8 and to recharge batteries 17, if they are of the rechargeable type.

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Thus, the UV light pen 1 can, for example, be used by a scientist in the field, via the internal batteries, and via the mains when back in the laboratory. A policeman could use it at the roadside, via the internal
5 batteries, and then place it in a holder in his car for recharging before he drove away.

As shown in the drawings, the batteries and optical axis are in a single line. However, the apparatus lends itself to further miniaturisation. For
10 example, the batteries 17 may be located parallel to and alongside the optical system of the Figure 1 embodiment, thus effectively halving the overall length and giving a small unit which fits neatly in the palm of a hand. Similarly, the optical axis may be bent by
15 the use of mirrors or prisms.

In the described embodiment, the batteries 17 are the largest components. Smaller batteries are known, e.g. button-shaped lithium cells, and these may be used to provide a further level of miniaturisation.

20 In another embodiment, the container is in the form of a key fob, e.g. such as is used in remote controls for locking and unlocking cars, etc. In this case, not only can the battery be alongside the optical system but the optical axis could be bent too to
25 achieve further miniaturisation.

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CLAIMS

1. A portable and self-contained apparatus for producing UV light, comprising:-
 - 5 i) a source of electrical power (17),
 - ii) a source of UV light (8) requiring a low operating voltage, and
 - 10 iii) means (15,14,13,9) to connect said source of UV light to said source of electrical power and to convert the electrical power to a form suitable to operate said UV light source.
2. Apparatus for producing UV light as claimed in claim 1, wherein the source of electrical power is an
15 internal battery.
3. Apparatus for producing UV light as claimed in claim 1, wherein the source of electrical power is an external battery or mains supply.
20
4. Apparatus for producing UV light as claimed in claim 2, wherein the internal battery is rechargeable.
5. Apparatus for producing UV light as claimed in any
25 preceding claim, wherein the UV light source is a miniature, low voltage bulb.
6. Apparatus for producing UV light as claimed in any one of claims 1 to 4, wherein the UV light source is a
30 light emitting diode.
7. Apparatus for producing UV light as claimed in claim 5 or 6, wherein the UV light source is mounted in a combined holder (9) and reflector (10).
35
8. Apparatus for producing UV light as claimed in any

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preceding claim, wherein the light and power sources and the connecting and conveying means are located within a housing (2).

- 5 9. Apparatus for producing UV light as claimed in claim 8, wherein the housing is adapted to direct the light produced by the source in a particular direction.
- 10 10. Apparatus for producing UV light as claimed in claim 9, wherein a hooded extension (4) (4a) is provided at an end of the housing to direct the light output into a particular direction.
- 15 11. Apparatus for producing UV light as claimed in claim 10, wherein the hooded extension is detachable from the housing.
- 20 12. Apparatus for producing UV light as claimed in any one of claims 8 to 11, wherein the housing is a tubular member adapted to fit in the pocket of an article of clothing.
- 25 13. Apparatus for producing UV light as claimed in any preceding claim, wherein a switch (5) is provided to turn the light on and off.
- 30 14. Apparatus for producing UV light as claimed in claim 13 when appendant to claim 12, wherein the switch is in the form of a pocket clip on the tubular member.
- 35 15. Apparatus for producing UV light as claimed in any one of claims 8 to 14, wherein the inside surface of the housing is optically reflective.
16. Apparatus for producing UV light as claimed in any preceding claim, wherein an optical system (25,24) is

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provided to control the UV light output.

17. Apparatus for producing UV light as claimed in claim 16, wherein the optical system includes a collimating lens (24).

18. Apparatus for producing UV light as claimed in claim 16 or 17, wherein the optical system includes an optical filter (23).

19. Apparatus for producing UV light as claimed in any preceding claim, wherein miniaturised components are used to produce a small, compact unit.

20. Apparatus for producing UV light as claimed in claim 19, wherein the axes of the electrical and optical components are mutually arranged to promote miniaturisation of the unit.

21. Apparatus for producing UV light as claimed in claim 20, wherein optical components are used to reduce the overall length of the optical axis.

22. Apparatus for producing UV light as claimed in any one of claims 8 to 11, wherein the housing is a key fob or the like.

23. Apparatus for producing UV light as claimed in any preceding claim, which includes means (39,40) connectable to a source of external electrical power.

24. Apparatus for producing UV light as claimed in claim 23, wherein said source of electrical power is a rechargeable battery and said connectable means is electrically connected to the battery for recharging the battery from the source of external electrical

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power.

25. Apparatus for producing UV light as claimed in any
preceding claim for use in detecting forged banknotes
5 and other documents.

26. Apparatus for producing UV light as claimed in any
one of claims 1 to 24 for use in identifying stolen
10 goods.

27. Apparatus for producing UV light as claimed in any
one of claims 1 to 24 for use in medical and/or
scientific work.

15 28. Apparatus for producing UV light substantially as
hereinbefore described with reference to and as
illustrated in Figures 1 to 4 or Figure 5 of the
accompanying drawings.

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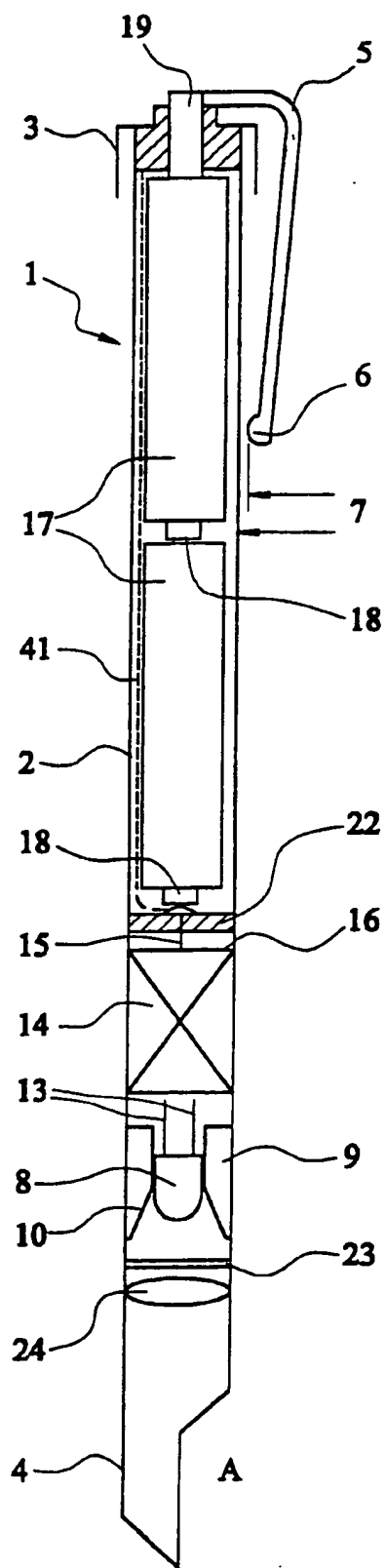


FIG. 1

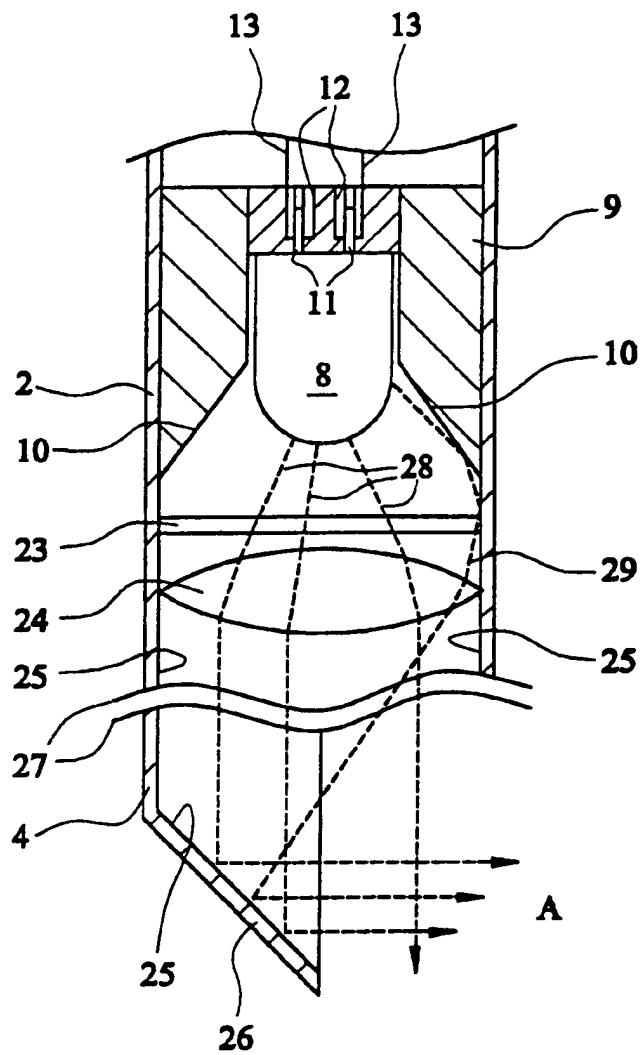


FIG. 2

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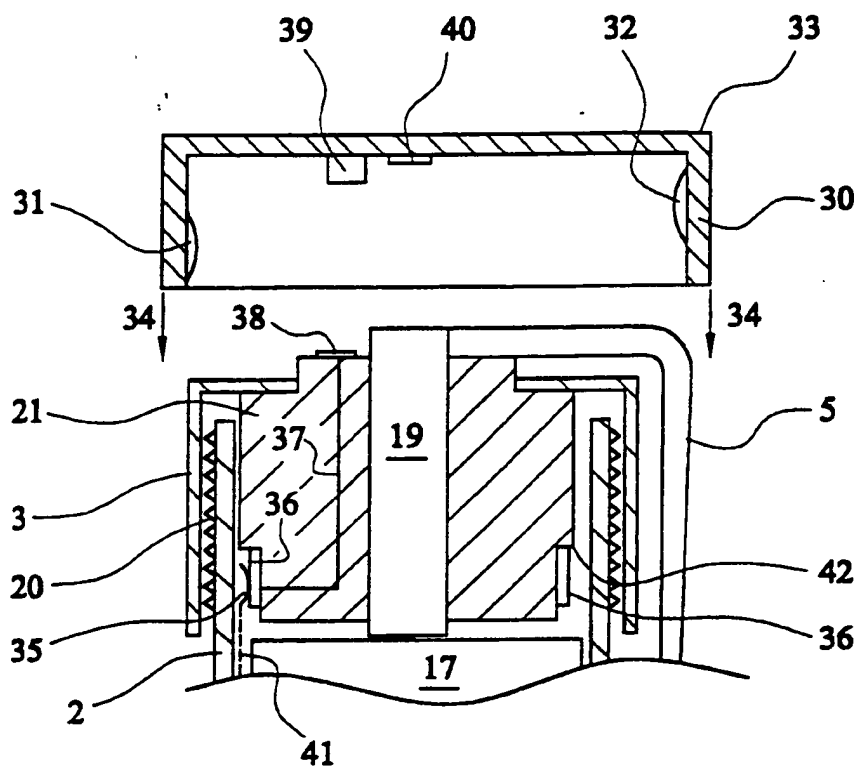


FIG. 3

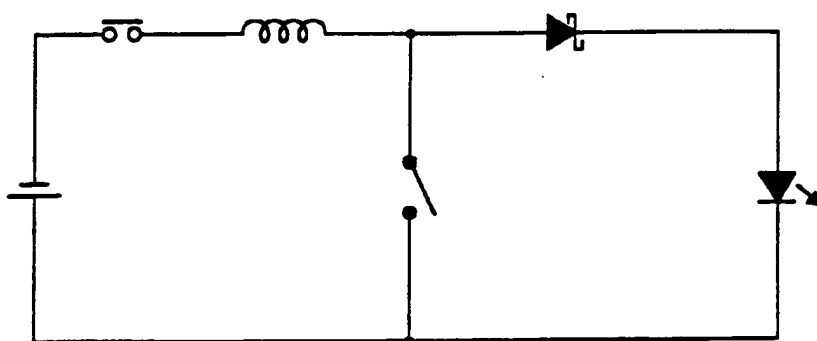


FIG. 4

-3/3-

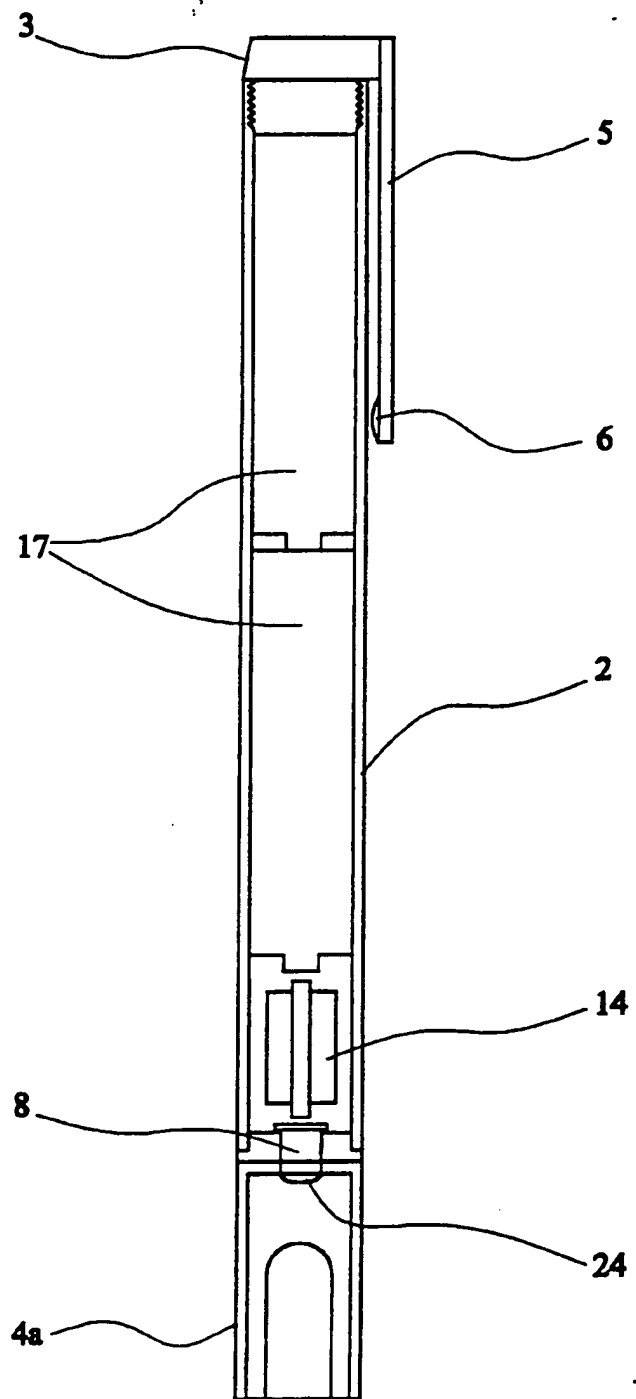


FIG. 5

INTERNATIONAL SEARCH REPORT

Intern. Appl. No.

PCT/GB 00/00421

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G07D7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/00421

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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